NASA Electronic Parts and Packaging Program (NEPP)

Title: LaRC FLEXIBLE MULTI-LAYERED ELECTRICAL CIRCUITRY

Nature of work: [ ] New Proposal [X] Continuing NEPP Work

Total $ Requested for FY01: **$ 155K** Civil Service Portion $ **35k**

Technology Type: [ ] Newly Available (COTS) [X] Emerging/Advanced

Project Area: [ ] Parts [X] Packaging [X] Radiation

Proposing Centers: Langley Research Center

Participating Center(s): JPL

(Estimated Center Participation, %$):

	GSFC		GRC	**67%**	LaRC	**33%**	JPL
	MSFC		JSC		other		

Collaborators: Imitec

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Objective(s): To evaluate the reliabilities of critical performance parameters of LaRC-SI film for application as substrate material for flexible multi-layered electrical circuitry.

Task Description: This effort will focus on the investigation and evaluation of non-adhesive, structurally-integrated flexible cable/circuit designs which are core enablers for meeting low weight/volume requirements for cheaper, better, faster missions into space.

Initial study of particle radiation induced arc-tracing indicates that LaRC-SI, an advanced polyimide material developed at Langley Research Center (LaRC) is highly resistive to accumulated charge breakdown. The task will initially pursue confirmation of these findings in a joint effort with the Jet Propulsion Laboratory's (JPL) 18-keV electron radiation thin film evaluation facility. These tests will be followed with study of the reliability effects of circuit pattern design on in-plane discharges and of plasma-etched blind/hidden Vias. The latter will be part of the qualification process for qualification of these Vias. The task will also include the effects of the shake/bake environment on the reliablility of the multi-layered performance for the LaRC-SI film circuits and evaluation of the reliability of LaRC-SI flexible fabrication techniques

Task Approach to Meeting NEPP Objectives: This study will assess the reliabilities of key performance factors of LaRC-SI for use as a flex circuit and flex cable material. Since embedding flex into multi-functional structure is one of the important technologies for programs such as the NMP, micro- and nano-sat technologies, and the next generation of sub-volt communication satellites, this study is key to streamlining the infusion path. The information will be disseminated to the NASA community by direct sharing of the results with NASA programs, by posting results on the LaRC NEPP web page, and by

presentation at appropriate conferences, such as the Annual Microelectronics Reliability and Qualification Workshop

Technical Background: The polyimide LaRC-SI has been utilized for a very wide array of applications since its inception at Langley Research Center, from backing of piezeoelectrics for actuators to mico-composites. In its film form LaRC-SI provides an exciting potential for advancing the applications of flex circuits and cables. For the past three years the development of the fabrication of LaRC-SI films and fundamental property measurements, both in-house and in the commercial sector, has been supported by other programs. The material's properties have been demonstrated to be superior to those of Kapton. LaRC-SI is self adhesive and has a high metal affinity. Both characteristics are particularly important for light-weight, highly flexible, multi-layered electronic circuits. The past year's activities for measurement induced through-the-thickness voltage breakdown due to absorbed charged radiation suggests that LaRC-SI is much more stable than high-temperature materials currently employed for flex circuitry. These data need to be confirmed. In addition, in-plane reliability effects of circuit pattern design on in-plane discharges and of plasma-etched blind/hidden Vias will be investigated. The latter will be part of the qualification process for qualification of these Vias. The task will also include the effects of the shake/bake environment on the reliablility of the multi-layered performance for the LaRC-SI film circuits and evaluation of the reliability of LaRC-SI flexible fabrication techniques.

Technical Approach: LaRC-SI film, fabricated at Langley and by commercial sources, will be evaluated. The study will use 1- and 2-mil thick film in FY01 and sub-mil thicknesses in the out years. The film will be patterned with circuits for study of through-the-thickness and in-plane breakdowns and with plasma-etched electrical Vias. Electron exposures will be conducted at JPL's 18-kev facility and at the University of Maryland's Linac facility in order to study the effects of charged particle radiation.

NASA Customers: Specific applicable NASA projects include NMP, Micro-Sat, Nano-Sat. Specific applicable NASA programs include SEE, OTTI, and ST. Direct customers who will benefit include NOAA and DOD.

Clearly Stated Deliverables:

- Study of radiation-induced, through-the-thickness arc tracing (all)
- Study of in-plane circuit patterned radiation-induced breakdowns. (all)
- Evaluation of the reliability and develop the improvement of plasma-etched Vias. (LaRC)
- Final reports for radiation-induced effects (all)
- Reports for Via fabrication study (LaRC)

Top Level Schedule:

Q1/01 – Q4/01: Particle radiation-induced, through-the-thickness arc tracing study (all)
Q3/01 – Q3/02: Evaluate in-plane circuit patterned induced breakdowns (all)
Q1/01 – Q4/01: Evaluation study of plasma-etched Vias. (LaRC)
Q4/01 – Q3/02: Report for in-plane and through-the-thickness breakdown characteristics (all)
Q1/02 – Q2/03: Conduct reliability study of plasma-etched Vias. (LaRC)
Q1/03 – Q4/03: Shake/bake study for the inter-planar reliability of multi-layered LaRC-SI flex
Q3/03 – Q4/03: Provide report for inspection methodology and acceptance/rejection criteria for multi-layered LaRC-SI circuitry (LaRC)
Q4/03 : Final report (all)

Leveraging: .

- Lightweight and Multifunctional Structural Systems, Spacecraft and Remote Sensing Technology Program

  Program provides support for the fundamental development of materials and processing techniques

- Space Environmental Effects Program

  Program provides for developing the data base for the effects of the space environmental parameter effects on the shielding materials.